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GEOLOGICAL SURVEY OF CANADA

A. P. LOW, DEPUTY HEAD AND DIRECTOR

PRELIMINARY REPORT

ON A PART

OF THE

SIMILKAMEEN DISTRICT

BRITISH COLUMBIA

BY

CHARLES CAMSELL.

OTTAWA:

GOVERNMENT PRINTING BUREAU

1617 1907 No 986

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GEOLOGICAL SURVEY OF CANADA
A. P. LOW, DEPUTY HEAD AND DIRECTOR

PRELIMINARY REPORT

ON A PART

OF THE

SIMILKAMEEN DISTRICT

BRITISH COLUMBIA

BY

CHARLES CAMSELL.

OTTAWA:
GOVERNMENT PRINTING BUREA
1617 1907
No 986

A. P. Low, Esq.,

Director Geological Survey of Canada

Dear Sir,—Herewith I beg to submit a preliminary report of my investigations in the Similkameen mining district of southern British Columbia carried out during the season of 1906. A topographic map, geologically coloured, of a portion of the district, accompanies the report.

My acknowledgments are due to many of the prospectors and claim owners in the district for much courtesy and kindness, some of whom willingly gave up their time to conduct the party over particular sections of country that they knew well, and which would have entailed considerable loss of time to us to have examined unaided. Mr. E. Waterman, resident manager of the Vermilion Forks Mining and Development Company at Princeton, very kindly supplied me with copies of the records of the various bore holes that have been drilled in the Tertiary coal basin. Mr. C. F. Law and Mr. Emil Voigt supplied me with much information on the history and development of the respective areas that they are interested in, on Bear creek and Copper mountain respectively. Mr. J. W. Waterman of Okanagan Falls was good enough to give me a detailed account of the several hydraulic ventures exploited in the Similkameen and Tulameen districts commencing from the year 1893. To these gentlemen I wish to express my thanks for their generous assistance.

I remain, sir,

Your obedient servant,

CHARLES CAMSELL.

Ottawa, April, 1907.

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PRELIMINARY REPORT.

Summary of Operations.

My instructions for the season were, to commence a topographical and geological survey of the Similkameen district of southern British Columbia, the object being to carry out for this district what has already been done for West Kootenay by Messrs. Brock and Boyd of this Department, namely, the publication of a map on a scale of four miles to the inch with a contour interval of two hundred feet. This sheet, which will be called the Similkameen sheet, will cover an area of about 3,500 square miles, and will embrace the mining camps of Bear creek, Granite creek, Copper mountain, Roche river, Hedley, Ollala and Fairview, including the country from the Okanagan valley to the Hope mountains, and from the International Boundary northward for a distance of about forty-five miles.

A work of this magnitude must of necessity occupy the attention of any field party for several seasons, but as certain sections of this area are economically of far greater importance than others I was instructed to confine the work of the first seasons to the more accessible and more developed portions of the district, leaving the remainder for a later date.

Princeton, the most central point for the region selected, was chosen as the headquarters for the season, and except for a hurried reconnaissance, at the end of the season, of the important camp of Bear creek on the Tulameen river, all the work was confined to a belt about eight miles wide lying between this place and the International Boundary. This belt, which covers an area of about 250 square miles, is the subject of this report and will be referred to as the South Similkameen district.

Though the early part of the season was very wet, no rain fell from the end of June until the beginning of September, so that the forest fires, which started in July, remained unchecked for several weeks, during which the pall of smoke rendered it impossible to carry on triangulation. For this reason the original intention of extending the topographic map up the Tulameen river had to be abandoned.

Transport of supplies was effected by means of pack horses obtained at Penticton. The party consisted of four and included Mr. J. A. Allan, assistant, and two men.

Topographical and Geological Work.

The topographic work consisted of a skeleton transit triangulation begun on the International Boundary Line, where it crosses the Pasayton river, and carried down the Similkameen river to Princeton, taking in a belt about eight miles wide. Two monuments on the Boundary Line furnished an excellent base for the commencement of the triangulation. As the whole belt south of Whipsaw creek is only traversed by one main trail, and the bordering country is very rough and heavily timbered, many traverses and stations necessary for a more complete survey had to be abandoned. An area of about 120 square miles, embracing the mineralized areas of Copper mountain, Kennedy mountain and the Princeton coal-basin, was surveyed in greater detail, and the position of this sheet was fixed on the skeleton triangulation. A map of the surveyed mineral claims and land preemptions compiled by the Lands and Works Department in Victoria was used as a base on which to plot the contour lines and other features of the topography. Elevations were obtained by aneroid, and referred to the levels carried through from Spence Bridge by the Canadian Pacific Railway Company in their survey of a location line down the Similkameen river. The elevation of the bridge across One-mile creek near its mouth was taken as the datum, and is reckoned at 2,000 feet above sea level. A geological and topographical map of this area on a scale of half a mile to the inch, with a contour interval of 100 feet, has been compiled.

By far the greater part of the geological work is confined to the mineralized sections of the belt, viz.: the Roche River camp, Copper and Kennedy mountains and the Tertiary coal-basin. These were done in some detail, while the work on the remainder of the country was only such as could be done in connexion with the topography on a hurried trip to and from the Boundary Line. The pack trail from Princeton to the Boundary Line follows the western side of the Similkameen river nearly all the way, and as one can only ford this stream in extremely low water a long strip of several miles south of Combination camp on the east side of the river was not examined at all, and is only conjectured to be covered by recent volcanic rocks.

Fossils occur only at the north end of the belt in the Tertiary sediments, and at the south end in an area of Cretaceous rocks, so that it has been found impossible to refer the rocks occurring in the central portion to any definite period of time. The greater part of this area is covered by recent volcanic flows, which are later than the Tertiary sediments.

In the Copper Mountain district, where a large batholithic mass of monzonite has invaded a series of metamorphosed sedimentary rocks, the two varieties of rocks have been grouped on the map under one geological colour, though the two are of widely different age. The reason for doing this is that it has been found impossible to separate them completely in the field. Except in the cañon of the Similkameen river, and where some development work has been done on the claims, outcrops of rock are not common and the igneous rock holds many isolated areas of the sedimentary rocks as inclusions in its body, and their boundaries were impossible to determine. To add to the complexity the whole mountain is cut by a great many dikes of varying composition, besides being traversed by many slips and faults along which alteration has taken place. These, coupled with the widespread mineralization, have wrought such profound changes in the rocks that it is now difficult in many cases to say what their original composition might have been.

A majority of the claims were visited and examined, but owing to the absence of many of the prospectors, who might have acted as guides in the district, some were unavoidably passed over. On few of these, however, has development work been carried to a depth of forty feet, and a majority of them have not been prospected below the level of surface oxidation. Consequently, many of the geological problems here encountered must remain unsolved for the present, or until such time as development work has progressed much further and the camp has reached the producing stage.

After completing the work on Copper mountain, and defining the Tertiary coal-basin, a short time was spent in a geological reconnaissance of Bear Creek camp and the platinum belt of rocks on the Tulameen river above Otter Flat. The importance of this field is such that with the short time at my disposal at the end of the season it was decided not to go into detail in any one section, but to go roughly over the whole ground with the view of making a more detailed survey in the near future.

Situation, etc.

The town of Princeton, which was the base of operations for the season, lies in the angle formed by the junction of the Tulameen river with the South Fork of the Similkameen river, and is thirty-one and a half miles in a direct line north of the International Boundary Line. The nearest point from here to which one can buy a railway ticket is Penticton at the south end of Okanagan lake. Penticton is joined to Princeton by seventy-five miles of good wagon road, over which a bi-weekly stage is operated. Princeton can also be reached from Spence's bridge on the main line of the Canadian Pacific railway. This latter route is about one hundred and twenty-five miles long, but has recently been shortened by the building of a branch line from Spences Bridge to Nicola lake, forty-five miles in length. A third route by which Princeton can be reached is over the old Hope trail across the mountains from Hope. Hope is distant about sixty-five miles, and the trail is merely a pack trail, which is not being much used at the present time, and is consequently not kept in very good repair. This route is only used in the summer time from May to October, as the high altitude of the summit and the depth of snow make the trail impassable for horses during the winter months.

Two separate lines of railway are projected and being built into the district. The Victoria, Vancouver and Eastern railway is being carried through from Midway up the Similkameen river and will eventually be extended through the Hope mountains and connected with Vancouver. It is expected that the line will be built through to Princeton in the summer of 1907. The Canadian Pacific railway has also had preliminary surveys made of a line southward from Nicola lake to Princeton and down through the valley of the Similkameen river. This will be an extension of the section of road already built through to Nicola lake and connected with the main line at Spences Bridge. The prospect of either or both of these railways passing through the country has brought the Similkameen district more before the notice of investors and capitalists and given a certain impetus to claim owners and prospectors, which comes as a relief after the dullness of the few preceding seasons. The country has many natural resources that have not been developed only on account of the lack of cheap transportation, and no future railway company need fear a scarcity of freight.

At present the Similkameen district above Hedley is only traversed by one trunk wagon road, which follows the valley of the river up to Otter Flat and then strikes northward to Nicola lake. From Princeton, a few short branches to run Whipsaw creek, Copper mountain and northward up One-mile creek; while from Otter Flat another branch, twelve miles in length, leads up to the mineral claims at the head of Bear creek. Over the rest of the district only a few pack trails lead to different points, such as the Hope trail, the Boundary trails up the Roche and Pasayton rivers, and a few others that have been opened up by prospectors owning claims in the mineralized areas that they lead to. The trail to the Boundary Line from Princeton was the most useful one to us, as it runs directly through the belt reported on from north to south. This leaves the Hope trail, near the mouth of Nine-mile creek, and ascending the steep hillside, south of Whipsaw creek, follows the trend of the river at an elevation of about fifteen hundred feet above it, and at a distance of a mile to a mile and a half back from it. It only descends to the river at the mouth of Copper creek, leaving it again to cut off the wide bend occurring between this and the mouth of the Pasayton river. At the mouth of the Pasayton the trail branches, each branch to cross the Boundary Line at different points, the one following the valley of the Pasayton and the other that of the Roche river.

Where there are no trails the ridges and summits of the hills are often open enough to afford easy travelling on horseback; but all the valleys and lower elevations in the belt surveyed are so heavily timbered that it is often impossible to get through with a pack-horse, and even difficult on foot without first cutting a trail.

Climate.

The climate of the Similkameen district about Princeton is an exceedingly pleasant one. Lying on the eastern side of the Hope mountains which catch much of the moisture drifting eastward from the Pacific, it occupies part of the interior dry belt of southern British Columbia. The rainfall is very light, and irrigation is necessary in the latter part of the summer wherever farming is carried on. The extreme upward limit of agriculture is slightly over three thousand feet above sea level, and as the greater proportion of country lies above this level it will be readily understood that the amount of cultivable land is not very large, and is confined to the lower benches of the valleys and to the Tertiary depression about the town of Princeton. Above this level, too, the plateau is subject to more or less severe summer frosts, and even in the lower levels of the district only the months of July and August can be counted on with any degree of certainty to be free from frosts. The soil is everywhere very good and yields excellent crops. Some wheat and other cereals are grown, but the most of the farmers are content merely with the production of vegetables for their own and for local consumption. Small fruits, such as strawberries, raspberries, currants and gooseberries are easily cultivated. Mr. Hunter has also successfully grown apples, and is experimenting in plums, cherries and pears, but the pear trees are still too small to judge whether they will be successful or not. Farther down the valley the climatic conditions become more suitable for fruit raising, and at Keremeos all these fruits, as well as grapes, are grown successfully.

Stock raising is carried on to a certain extent, but the winters are too severe and the area of land on which cattle could feed too limited to make this industry very general.

I am indebted to Mr. Hugh Hunter, mining recorder at Princeton, for the following notes on meteorology for the year 1904:—

Mean summer temperature..	67.96°	
Mean winter temperature, December to March	33.23°	
Highest temperature	101°	Aug. 4th.
Lowest temperature	—27°	Feb. 9th.

Precipitation –

Rain..	7.7 inches.
Snow...	65 "
First snowfall to remain.....	Dec. 19th, 1903.
Snow disappears from valleys..	April 13th, 1904.

History and Development.

Placers.—Ever since the year 1860, when placer gold was first discovered on the Similkameen river, above Princeton, by a government prospecting party under Mr. Allison, mining and prospecting has been going on continuously to a greater or less extent up to the present time. A year or two after this discovery most of the white miners who were working on this stream and the Tulameen river were drawn away to the Cariboo country by the great excitement following the discovery of Williams and Lightning creeks, and only a few Chinese were left. These continued to work the old localities without making any attempt to discover new ones until the early eighties, when a number of white miners returned, and an increased activity was manifested in prospecting, both for placers, as well as for lode minerals. The discovery of coarse gold on Granite creek, in 1885, caused considerable excitement and resulted in the biggest rush in the same year that the Similkameen has ever seen. Other discoveries higher up the Tulameen quickly followed, and the maximum output was probably reached in 1886, the figures given for that year in the report of the Minister of Mines being $203,000. On the southern portion of the river, though placer gold is found as far as the Roche river, the most productive bars were found below the mouth of Whipsaw creek, on Whipsaw creek itself and on Nine-mile, a tributary of the latter heading near Granite creek. These bars have now been worked out and no placer mining has been attempted on them for several years.

The most interesting feature that has been developed in connexion with placer mining on the southern portion of the Similkameen river and Tulameen river, is the occurrence everywhere of platinum in association with the gold, and indeed this district has proved to be the most productive of that mineral that has yet been discovered on the North American continent. Dr. Dawson has estimated that from 1,400 to 2,000 ounces of platinum were obtained in the district in 1887 at a time when placer mining was at its height, and previous to that it was not considered worth while saving in the clean up. At the present time placer mining is confined to Granite creek and the upper part of the Tulameen river, and is carried on by only a few whites and some Chinamen. The annual output of platinum has now decreased to not more than forty to fifty ounces. Owing to the enormous rise in the price of platinum, however, it is altogether likely that in the ensuing year some attempts will be made by interested parties to work some of the higher bench deposits of gravel which are known to carry platinum, but which necessitated too large an outlay of capital to have been worked before.

Lode mining.—Coincident with the increase of activity in placer mining in the early eighties was corresponding interest in the search for the source of these placers in the rock. Copper ore, carrying some values in gold and silver, was discovered at the mouth of Friday creek, and also on the opposite side of the Similkameen, on what is now known as Copper mountain. Two claims staked by Mr. Allison in 1887 on the side of the valley opposite the mouth of Friday creek were Crown granted, and a good deal of prospecting by tunnelling was done. Apparently the results obtained did not justify the continuation of the work, and the ore being too low grade to pay the claims were abandoned shortly after. On Friday creek, however, some prospecting and development work has been carried on almost continuously since the year 1887 up to the present time. One of the first claims located—the Victoria—situated about 400 yards up the creek from its mouth, was more developed than any other, and some pockets of beautiful bornite ore discovered. This was found to be of such a high grade that some of it was carried out on pack horses and shipped to a smelter. This claim is still being held under the name of the Gladstone, but the work done on it is only such assessment as is necessary to prevent it from lapsing.

On Copper mountain itself the best known claim, and, with the exception of the two staked by Mr. Allison, in 1887, the earliest one recorded, is the Sunset. Though copper ore was known and discovered in this neighbourhood by Jameson, in 1888, while trapping in these mountains, no claims were taken up until the discovery was reported to R. A. Brown. Brown staked the Sunset claim, but the claim lapsed and was restaked again in 1896, and in this year the first assessment work was done on it. The following year some ten or a dozen claims were staked, mostly adjoining the Sunset, and in 1898 options were taken on some of these by eastern capitalists. These men, however, were discouraged by the difficulties of transportation and allowed the properties to drop.

In 1898 and 1899 there was a great influx of prospectors to this district, and the Tulameen and the remaining areas of Copper mountain, Kennedy mountain, Friday creek and Combination camp were staked. Voigt's camp, on Wolf creek, was also located at this time. From 1898 to 1900 interest in Copper mountain and neighbouring properties was keen, and much money was expended in prospecting different claims. Options were given on several claims around, including the Sunset, to eastern capitalists, but owing to differences with the claim owners and for other reasons the options were again dropped. At the same time the old Copper Mountain wagon road was built by several of the claim owners.

After 1900 very little work, outside of the necessary assessment work, was done until 1905. At Voigt's camp, however, a few men were kept steadily at work on the claims, and in 1904 the present wagon road from Princeton was built by Mr. Voigt, with some assistance from the government.

In 1905 the British Columbia Copper Company took options on ten or twelve claims around and including the Sunset, and work was carried on for about eleven months. A diamond drill was brought in and much deep drilling done, but the results were not made known to the public.

Hydraulic mining.—In 1893 some prospecting and surveying was done on the east side of the Similkameen river, above Princeton, by parties associated with W. C. McDon , with a view to working some of the benches stretching back from the river by hydraulic methods. Gold was found in all the test pits, but the bed rock was not sufficiently high above the level of the stream to afford a good dump. This, with the fact that a ditch, seven miles in length, to carry water from the Similkameen river on to the ground, would only give a head of 116 feet, forced the promoters to abandon their project.

In 1895 the Anglo-American Company was formed by Captain S. T. Scott, with the object of working some ground situated on the west side of the Similkameen river, just above the mouth of Whipsaw creek. A ditch two miles in length brought water from Whipsaw creek, and under a head of 320 feet this was supplied to two No. 5 Monitors at the foot of the bench. Sluicing was carried on for a period of eight days, when it was found that the bedrock here also was too low to afford a dump for the tailings, and they were constantly blocking the channel and forcing the water back over the flat. The expense of keeping the sluice boxes free from the tailings, and the fact that bedrock was not reached in the pit, caused the company to abandon the work and go into liquidation.

The most successful attempt at hydraulicing was that undertaken by Mr. W. J. Waterman in 1895 on some ground about three miles south of Princeton. This ground had formerly yielded from $5.00 to $10.00 to the hand, and had been worked both by whites and Chinese. Water was obtained from a spring and stored in a reservoir immediately above the bench to be worked. A self acting gate to the reservoir was built with the intention of using the water as a bucking hydraulic. The water was stored at night behind an old beaver dam above the reservior, and during the day was allowed to run into the reservoir which it filled two or three times an hour. The gate acted automatically and let out a head of about 2,000 miners inches for seven or eight minutes. When the reservoir was empty the gate closed, and the boulders, etc., in the pit were cleared up and the ground got ready for the next run. In November, 1895, a partial clean up gave results of from twenty-five to thirty-five cents per cubic yard of ground moved and paid expenses. The next year the property was sold to the Vermilion Forks Mining and Development Co. More water was brought from Stevenson creek and a small monitor installed under a hundred foot head. Two runs were made in 1898 and the results obtained gave ten to fifteen cents per cubic yard of ground moved. The amount of water was not sufficient to move the heavy wash, and trial surveys were run to bring more water from Nine mile creek. The amount of workable ground, however, was not large enough to warrant the expense of such a ditch and the work was dropped.

The river bars at the mouth of Friday creek fifteen miles above Princeton were at one time found to be very rich. Here a trial pit was also opened up. A ditch one half mile in length was dug and a short pipe line with a monitor installed. Work was carried on for part of one season and in the next spring when operations were about to be commenced it was found that the whole ditch system had been washed away into the stream. The claims were then abandoned and have lain idle ever since.

On the Tulameen river the earliest attempt at hydraulicing was made by a group of Vancouver men who built a flume and ditch from Eagle creek with the intention of recovering the platinum from a bench a short distance below this point. The bench was small and was soon washed out, with what results was not ascertained.

On Granite creek, from which probably more placer gold was recovered than any other part of the Similkameen district, some bench claims were opened up by Captain Scott, Robert Stevenson, W. E. Hogg and others. A flume four miles in length was laid and work began on the Swan claim and at its upper end. The gold here is very coarse and probably much was recovered, but the company shortly after went into liquidation and the court is said to have cleaned up about $900 00 from the sluice boxes. Mr. Hogg afterwards worked a small pit four miles below the mouth of Granite creek and washed out the gravel from an old high channel of the Tulameen river. It is believed to have paid for the season, but the pit was filled up with wash from the mountain side the next spring, and never reopened.

Drilling.—Boring operations for lignite began in 1901, and have been prosecuted by several parties interested in the development of the Princeton coal basin. The Vermilion Forks Mining and Development Company is the largest holder of coal claims and it has sunk six bore holes to test its properties. Two others have been sunk by Blakemore and one by Sharp; and with the exception of Sharp's bore hole all have been sunk in the valley of the South Similkameen river between Princeton and Ashnola.

Previous Geological Work

The first geological work done on the southern portion of the Similkameen of which we have any record is that of Mr. H. Bauerman the Geologist to the North American Boundary Commission. This work was done in the years 1859 to 1861 at the time the Boundary Line was first being defined, but although a report had been prepared by Mr. Bauerman it was never printed until done so by the Geological Survey Department in 1884, with the permission of the author. In this survey Mr. Bauerman crossed the belt now being reported on by two routes. His northern route was by the old Hope trail, entering the belt by Whipsaw creek and following down the valley of the Similkameen river. His southern route lay down the valley of the Roche river to the mouth of the Pasayton, from which point he struck across the divide to the Ashnola river by a trail long since abandoned. His work was of a preliminary character, and he makes no mention whatever to lode minerals of economic value occurring in the belt, and refers only briefly to the placer mining on the southern portion of the Similkameen that was at that time carried on by Chinamen, and to the occurrence of lignite beds on the Tulameen river.

In 1877 Dr. G. M. Dawson spent the season in a geological exploration of the southern interior of British Columbia, and one of the routes followed, viz., the Hope trail, took him through the Tertiary basin about Princeton and down the Similkameen river, on precisely the same course as that followed by Mr. Bauerman. A detailed report of his observations is found in the Report of Progress, 1877-78. Owing to the discoveries of rich placers in 1885 on Granite creek and the Tulameen river Dr. Dawson again visited the district in 1888, but in the short summary which appears in the Annual Report of that year he deals entirely with the Tulameen river and its tributaries. This was the last survey made by the Geological Survey Department until the work of this year.

In 1901 Mr. Robertson, Provincial Mineralogist for British Columbia, examined and reported on the Princeton and Copper Mountain district, and went as far up as the head of one of the branches of the Roche river. Mr. Robertson's observations were confined entirely to the mineral claims in the different camps, and he makes no reference to the general geology of the district.

In 1901, the International Boundary Commission Survey commenced the construction of a topographic map of a five mile belt lying along the Boundary Line. Dr. R. A. Daly was attached to this as Canadian geologist to the commission, and his observations, extending over this belt, have added much to our knowledge of the geology of the southern border of the Similkameen district. Using the topographic map so constructed as a base the boundaries of the different geological formations met with have been accurately sketched in and other geological data added.

Physiography.

The South Similkameen district lies in a part of what has been called by Dr. G. M. Dawson the great interior plateau of British Columbia. In the southern part of the Similkameen district, however, it partially loses the chief characteristics of a plateau, which are so well exemplified in the region to the north of this district, and which gave the author of the name the reasons for calling it such, and it here becomes gradually more mountainous, until it finally merges into the high rugged and snow-covered peaks of the Cascade range to the south of the International Boundary Line. In the northern part of the belt surveyed, and in the country to the north of the Similkameen and Tulameen rivers, the plateau features become more pronounced and the ruggedness of a mountain region is lost. In looking southward over it towards the Nicola lake from some of the higher points the eye appears to travel over a gently undulating surface showing a succession of rounded and generally wooded hills, and nowhere any sharp and rugged peaks or any banks of snow.

Above Princeton the southern portion of the Similkameen river flows in an almost north and south course until it forks some twenty-five miles south of here. The main branch or Pasayton river continues in the same course up to and across the Boundary Line, while the west branch or Roche river comes from the southwest. The name Roche river was originally only applied to a small branch of this stream flowing into it from the south about twelve miles above the mouth of the Pasayton, but in recent years it has become customary to refer to this larger stream as the Roche river, while in reality it should retain its original name of South Similkameen.*

The valley of the Roche river is wide and flat, and filled with gravel and wash, which frequently forms terraces on either side

*The Geographic Board, however, have decided that the South Similkameen shall be called the 'Similkameen.'—Ed.

of the river. These terraces are often cut through by the stream, forming steep cut banks of fifty or one hundred feet in height. The gradient of the stream is comparatively low, and the sides of the valley generally slope back easily to a height of about 2,000 feet above the river. The Pasayton river, however, occupies a much narrower valley and the stream is much more rapid.

About a mile below the junction of the two streams the southern portion of the Similkameen river enters a deep and narrow cañon, through which it flows for a distance of about eighteen miles, or as far as the mouth of Whipsaw creek. The gradient of this part of the stream is very steep, being at least forty feet to the mile and very probably more. As the lower portions of the valley are usually very precipitous and carved out of the solid rock, gravel benches rarely occur, and it is seldom possible for wash to find any lodgment on its sides. The bed of the stream is filled with large boulders, rounded as well as angular, and for these several reasons it is impossible to ford this section of the stream except in the late summer when the water is very low.

Below the mouth of Whipsaw creek the stream enters the low, shallow Tertiary coal basin, and the change in character is very abrupt. Here the grade becomes slightly easier though still very steep, and the banks of the valley are usually composed of unconsolidated material, and only occasionally are there exposed sections of the lignite-bearing measures.

The tributaries of the southern portion of the Similkameen river are few and insignificant, the most important being Whipsaw creek and Copper creek, both flowing in from the west, and each entering the main stream by deep and narrow valleys. The former heads with one of the branches of the Skagit, and its valley is followed from one end to the other by the old trail from Hope to Princeton.

Both the Roche and the Pasayton rivers draw their waters from the high range of mountains lying on and to the south of the International Boundary Line, their branches interlocking with those of the Skagit drainage and the Methow, the latter flowing directly southward into the Columbia river.

The basin occupied by these two streams is enclosed between two forks of the Cascade range of mountains, which, running up northward through the State of Washington, divides just south of the Boundary Line. The western or true Cascades, or Hozameen range, forms the divide between the Roche and Skagit rivers, and runs up northward to the west of the Tulameen, and is there locally known as the Hope mountains; while the eastern Cascades or Okanagan range strikes slightly east of north and lies to the west of the Pasayton and Ashnola rivers. The western of these two forks is the more persistent and stronger range, and its summits show very little diminution in elevation or ruggedness of relief beyond the limits of the Similkameen sheet to the north. The eastern fork, however, is not so persistent or well defined. Its summits at the Boundary Line sometimes attain an elevation of 8,500 feet, but these gradually dwindle down, until north of the Similkameen river its highest points are little more than 7,000 feet and the whole range gradually sinks into and becomes a part of the great Interior plateau.

The elevation of the town of Princeton, as deduced from instrumental levels carried through from Spokane by the engineers of the Victoria, Vancouver and Eastern railway is 2,120 above sea level, while that of the townsite of Allison two miles below is given as 1,978 feet by levels carried from Spences Bridge by Canadian Pacific Railway engineers. There appears to be a discrepancy here, and a difference of about 100 feet between the levels of the two railway surveys. The levels of the Canadian Pacific Railway survey were used in obtaining the elevations for the topographic map.

Taking Princeton, which lies in a shallow depression occupied by Tertiary sedimentary rocks, as the central point in the curve formed by the two forks of the Cascade range of mountains, there is a marked rise in slope of the lines radiating to the west, south and east, while the gradient to the north is almost imperceptible. In this curve the hills have all been worn down below the limit of intense alpine erosion, and now appear as rounded ridges and dome-shaped summits of gradually increasing elevation towards the circumference. Only towards the circumference of this curve do the summits attain an elevation greater than the tree line, which in this district is approximately 7,000 feet above sea level, but with the exception of the immediate vicinity of Princeton these are usually well wooded with spruce, pine, balsam, and tamarac. This rounded outline and regularity of form, while in the main due to erosion, is also in part the result of the filling in of old irregularities of the surface by the Tertiary lava flows which still cover such a large proportion of the surface of the belt. Glacial action, both the action of erosion as well as that of deposition, has also been instrumental in reducing the vertical relief.

Many evidences of recent development in the topography occur. The southern portion of the Similkameen river from the Pasayton to the mouth of Whipsaw creek occupies a deep, narrow V-shaped valley indicative of a comparatively recent uplift, which imparts to this portion of the stream increased vigour and power of erosion. The valley of the Tulameen river too, above Otter creek, as well as many of its tributaries, is very narrow and steep, showing that the drainage has not been very long in operation since the change in elevation.

Numbers of terraces and deposits of gravel also occur at various elevations on the sides of the valleys to a height of 3,400 feet above sea level. The higher ones of these appear to have been formed when the whole valley was filled with water up to these levels, while others nearer the river and lower are the result of the action of the present streams in cutting down their beds. As a rule the higher ones only now occur as small remnants of once more extensive terraces, formed in the period immediately following on the disappearance of the Cordilleran glacier, and which have since been reduced in size by the ordinary atmospheric agencies of erosion. These are the most apparent evidences of comparatively recent changes of level.

Accompanying these changes of level, and either a direct result of them or of the blocking of ancient channels by recent volcanic flows, have been some striking changes of drainage. The most marked instance of this is the deep valley of Smelter lake and Wolf creek, now occupied by a stream inconsistent with the size of the valley. It seems probable that this valley of Wolf creek with its continuation through Smelter lake once carried a great part of the drainage of the southern portion of the Similkameen river, but that the filling up of parts of its channel by recent volcanic flows, or the same uplift which caused the southern portion of the Similkameen river to cut its deep cañon, also forced the stream into its present roundabout course through the Tertiary basin about Princeton. All the streams entering this valley from the south, above and including the Coldwater river itself, occupy hanging valleys, so that they debouch in waterfalls or have been forced to cut deep cañons down to the level of the trunk valley.

GLACIATION.

During the glacial period the great Cordilleran glacier covered all the summits north of the Boundary Line in this belt. The conditions we now find existing as a result of this glaciation tend to show that the glacier was losing its great power of erosion, and was rather depositing its load of débris. This is evidenced by the small number of grooved and striated rock exposures and "roches moutonnees," and by the thick and widespread deposit of rock detritus on the summits of the hills as well as in the valleys. Some striae were noted on the southern part of the belt on the upper slopes of the Pasayton and Similkameen valleys, but these are practically valueless as an indication of the general trend of the main body of the ice, for the direction of flow would here be entirely influenced by the course of the valley. All striae noted were found to conform to this course. On a wider area and one traversed by valleys running in a diversity of directions, such as that covered by the Kamloops map sheet of Dr. Dawson, the average of many readings obtained on points that are uninfluenced by nearness to any great valleys would give very nearly the course of the upper portion of the ice sheet; but as the sheet now being reported on lies entirely in the valley of the southern portion of the Similkameen river and its tributaries, all striations would be more or less influenced by this valley, particularly as the trend of the valley only diverges a few degrees from what has been reckoned to be the general trend of the ice sheet over the Interior Plateau.

By far the greater proportion of drift is unmodified material derived from the breaking down of rocks within a short distance of where it now lies. This drift is so widespread that it is usually only where it has been cut into and washed away by streams that exposures of the solid rock can be found. It also imparts to the topography an appearance of fairly mature erosion, giving to the hills in the belt a rounded and graded outline which is so characteristic a feature of the whole Interior Plateau.

Prospecting for mineral deposits becomes, on account of the mantle of drift, more difficult here than in a region where the strength of glacial erosion had been greater. The heavy growth of timber too adds to the difficulties. The tree line in this belt is approximately 7,000 feet above sea level, and as it is only a few points in the southern portion that exceed this elevation, it will be seen that the area of surface covered by timber far exceeds that which is devoid of it.

AGRICULTURAL LAND.

Stratified deposits of sand and clay are cut into and exposed a short distance below the mouth of the Roche river. These appear to have been laid down in still water along the southern face of a northward retreating glacier. The water derived from the melting of the glacier probably for a while discharged southward across the divide into the Skagit river, but after this had been sufficiently lowered to prevent an outlet in this direction a lake was formed in which these beds of clay and sand were deposited. On the still further retreat of the glacier this water would probably find an outlet northward and eastward down the valley of the Similkameen river. Terraces of gravel and sand whose origin is probably contemporaneous with the deposition of these stratified deposits, and which were formed along the shores of such lakes, are frequently found adhering to the sides of the main valley at elevations above that of the stratified deposits. Other terraces, which occur at lower elevations farther northward, of undoubted lake origin, were formed when the water had subsided still lower.

The White Silt deposits, which are so well shown on Okanagan lake, and which mark a period near the final disappearance of the glacier, are not represented in the district, though the lowest depression in the belt, 2,000 feet above sea level, is well below the highest level at which these deposits are found in other parts.

Hanging valleys have already been referred to as occurring on the valley of Wolf creek and on the upper part of the Tulameen river, but whether these can be attributed to glacial action or to a quite recent uplift and tilting of certain sections, it is at the present time impossible to say.

The thick covering of glacial drift, though somewhat of a hindrance to the speedy development of the mineral resources of the district, must be reckoned as one of its assets in that it has produced a considerable extent of excellent farm and grazing land. The open, rolling hills all around the town of Princeton are covered with beautiful bunch grass, and support herds of cattle and horses throughout the summer season. At present the cultivation of farm land is almost entirely confined to the flats of the Similkameen and Tulameen rivers and their tributaries. A few pre-emptions have been taken up on the higher slopes of the valleys where the surface is not too steep, but the limit at which farming is carried on can be put at 3,200 feet above sea level. Below this level is a good deal of land yet untouched, which could support a much larger population than the country now holds.

SOLID GEOLOGY.

Though much that follows has already been fully dealt with in the Director's Summary Report for 1906, it must be repeated here; but a change hos been made in the form of classification and also in the naming of the igneous rock of Copper mountain. Both of these were necessitated after a microscopic study of the numerous rock samples collected in the district.

Geological work on the southern portion of the Similkameen becomes very difficult on account of the great variety and complexity of the rock formations, as also on account of the thickness and widespread covering of drift. Plutonic, volcanic and sedimentary rocks are all present, covering a period from Palæozoic to later Tertiary times. Fossils occur in the Tertiary lignite basin, about Princeton, and also in the Cretaceous sandstones of the Roche river, but the remaining sedimentary rocks—limestone, argillite and quartzite—are either unfossiliferous or have been so badly crushed as to destroy any remnant of animal life that they ever contained. Contacts between the igneous and sedimentary rocks are rarely exposed, so that it is difficult and very often impossible to establish geological relations. Added to this is the difficulty in the southern half of the belt of travelling anywhere except on trails that have been cut by prospectors through the bush. This latter difficulty, however, does not hold in the northern half, where one can usually obtain access to any part, whether there is a trail or not.

The formations met with and their approximate or relative ages, are as follows:—

(1) *Glacial and recent deposits.*

(2) *Post Oligocene*—

Volcanic, consisting of andesites, basalts, trachytes, tuffs and breccias.

(3) *Oligocene*—

Sedimentary, consisting of sandstones, shales, clays with seams of lignite.

(4) *Cretaceous*—

Argillaceous sandstones, grits, conglomerates and slates.

(5) *Post Palæozoic*—

Remmel granodiorite; monzonite of Copper mountain.

(6) *Palæozoic*—

Limestone, quartzite and argillite of Copper mountain. Green and spotted schists, talc and graphite schists, mica and hornblende schists, with some limestone and siliceous bands.

Palæozoic.—The oldest rocks in the district are the Roche River schists, which cover an area about the junction of the Roche river with the Pasayton. This area extends from the cañon below the junction of the two streams four miles up the Roche river, and to a point eight miles up the Pasayton, its southern contact on the latter stream being the batholithic intrusion of Remmel granodiorite, while on the Roche river it is in contact with a band of gneiss, which may or may not be only a phase of the Remmel granodiorite. On all other sides the schists are overlaid by recent volcanic rocks lying a short distance back from the river banks. The schists are very varied in character. On the south are micaceous and hornblendic schists, frequently very siliceous and becoming gneissic, and holding some bands of crystalline limestone. The northern part of the area is occupied by soft green spotted and chloritic schists, with smaller bands of graphitic and talc schists, the latter being frequently mineralized and traversed by quartz-filled fissures. It has been found impossible to determine the age of these rocks, and though some members of the series have a lithological resemblance to the Archæan of the Shuswap series, the green and spotted schists are more probably highly metamorphosed volcanic rocks.

The limestones, quartzites and argillites cover a very limited area, but are important as being associated with some of the ore bodies in the southern part of the Copper Mountain district. They also form a highly altered and metamorphosed band crossing the Similkameen river below Allison, and lying between and under young volcanic rocks on the west and a great mass of granite on the east. They also extend some distance south of Copper mountain, until they are covered by Tertiary volcanics. They appear to resemble somewhat the Cache Creek series of the Kamloops district. They have been cut and greatly disturbed by later intrusions of igneous rock, and so much of these beds has been destroyed that they now frequently only appear as islands or "roof pendants" in batholithic masses of rock. The limestone is very often white and crystalline, and the argillites and quartzites are very highly altered and may in some cases have taken on a crystalline structure. In addition to the metamorphism they have undergone some fracturing and brecciation. Much of these sedimentaries is probably covered by volcanic flows, and much also has been digested and assimilated by eruptive masses of plutonic rocks, and the parts that remain are only remnants of once more extensive sediments that covered a great part of southern British Columbia.

Post-Palæozoic.—These are batholithic intrusions, and under this head are classed the Remmel granodiorite of the Pasayton river, the gneiss of the Roche river, which is probably only a phase of the Remmel granodiorite, and the monzonite of Copper mountain. The Remmel granodiorite is cut across by the Pasayton river, and extends northward from the Boundary Line for a distance of four miles to its contact with the mica schists. South of it is a large area of Lower Cretaceous rocks. The typical rock of this area is composed of hornblende, biotite, quartz and orthoclase feldspar. On the same strike as the Remmel granodiorite on the Roche river is a band of gneiss about two miles wide. This is not so coarsely crystalline and is so much more basic in composition as to be almost a diorite, but it is possible that the two may have been produced from the same magma.

The country rock of Copper mountain is a monzonite, petrographically very similar to the monzonite of the Rossland district. Its texture is granitic. The predominant feldspar is plagioclase, generally idiomorphic, and occurring in elongated crystals. Much orthoclase feldspar also occurs. The ferromagnesian minerals are biotite and augite, in varying proportions. Usually the augite is in excess of the biotite. Hornblende also occurs, but never in as great a proportion as either the augite or biotite, and probably only as an alteration of the augite. Iron or copper sulphides appear to be always constituents of the mass and occur as idiomorphic crystals disseminated through the body of the rock.

This monzonite is best developed in the south and east of Copper mountain, where it has not been affected by mineralizers or altered by later igneous intrusions. In places where this is in contact with some remnants of the older sedimentaries a gneissic structure has been induced in it. To the centre and north it has been fractured and brecciated, and is now traversed by many little veinlets of calcite, magnetite and feldspar. The rock has also become finer in grain, and large biotites are often developed in the zone of fracture. The contact between the monzonite and the sedimentaries is very irregular wherever it is exposed. It is rarely sharply defined, and in many cases no definite boundary can be assigned to the igneous rock. The monzonite occurs under so many different phases, and is cut by so many different types of dikes with which it becomes intimately mixed, that it is often difficult in the field to separate the different intrusions.

Cretaceous.—Lower Cretaceous rocks cover a wide area in the southwest corner of the district. They appear on the Pasayton river, just north of the Boundary Line, and striking about 330° across the Roche river, about six miles above the junction of that stream with the Pasayton. At both these places they are seen to overlie the eruptive rocks. The beds consist of hard sandstones and grits, interbedded with black and red argillaceous slates, all of which appear to have suffered much stress and pressure, for the angles of the dip are now all high, being usually about 50°. On the Roche river the bottom bed is a conglomerate, which rests directly on the gneiss to the north of it. The actual contact is masked by drift, but from the evidence of the pebbles contained in the conglomerate the latter appears to rest unconformably on the igneous rock, and the material for the conglomerate was derived from the breaking down of the igneous rock. Dr. Daly has estimated that a thickness of 10,000 feet of arkose sandstones alone was deposited in this down warped Cretaceous sea, so that the conditions for their deposition must have covered a relatively long period of time.

The beginning of the Tertiary times witnessed some colossal disturbances in this portion of the earth's crust, which was later accompanied by much volcanic activity. The Cretaceous strata were folded and upheaved to form the rugged conditions obtaining in the Hozameen range, and it is probable that the same causes were responsible for the fracturing and fissuring of the monzonite of Copper mountain. If this is so the beginning of the formation of the Copper mountain ore bodies must have dated from this period of disturbance.

This period of disturbance and mountain building must have terminated, or was at least temporarily arrested, about the close of the Eocene period, and a short period of comparative quiescence followed, during which the lignite-bearing sediments were deposited in a local sea of transgression. Many oscillations of level of this sea are necessary at this period to account for the formation of the different seams of lignite, and the final uplift was followed by a prolonged period of tremendous volcanic activity, during which the greater part of the country south of Princeton was covered by volcanic rock.

Oligocene.—These sedimentary rocks alone in the northern part of the district cover an area of nearly fifty square miles, the basin being fourteen miles long with a variable width of from three to five and a half miles. They consist of thick beds of sandstone, with clay, shales and several seams of lignite. The base of the series appears to be a very coarse-grained sandstone containing many large rounded white feldspars in a matrix of calcareous material. This rests on the eastern side of the basin, on the Copper Mountain series of rocks, while on nearly all other boundaries the sediments dip under the more recent volcanic rocks, which lie as sheets on them. In parts also these volcanics have thrust themselves through the sediments and now appear as islands in the older rocks. The strata do not now lie horizontally, but have been tilted at low angles, making an irregular series of folds. Some faults also occur.

Many drill holes have been bored in this Tertiary basin in search of lignite seams, and with some good results. Most of them, however, were put down at or near the edge of the river, and only one near the western edge of the basin. By the kindness of Mr. Ernest Waterman, manager of the Vermilion Forks Mining and Development Company, copies of the records of these drills have been obtained. These have disclosed the thickest lignite seams to be in the vicinity of the town of Princeton, where a bed over eighteen feet in thickness was struck at a depth of forty nine feet below the surface. The hole in which this seam was found was sunk near the bridge over the Similkameen river to a depth of 280 feet. In this hole lignite seams, aggregating thirty-five feet seven inches, were crossed in the first ninety feet, while the rest was in shales and sandstones.

The following is a record of this drill hole:—

Material	Thickness.		Depth.	
	ft.	in.	ft.	in.
Gravel	11			
Shale	21	6		
Coal	1	6		
Sandstone	0	5½	10	5½
Coal	6	7½		
Clay	1	10	48	11
Coal	18	5½		
Shale	3	1		
Carbonaceous shale	4	6		
Clay	0	5		
Carbonaceous shale	0	8		
Sandstone	1	7		
Fire clay	2	1		
Coal	0	2		
Shaly coal	1	1		
Shale	1	0	81	11½
Coal	1	8		
Clay	1	1		
Coal	1	6		
Shaly coal	1	2		
Coal	1	6		
Clay, shale, etc.	26	4½		
Sandstone	31			
Clay, shale, etc.	79	6	227	
Sandstone	44	6		
Clay, shale, etc.	8	6	280	

Aggregate of clean coal, 34 feet 5 inches.

One and a half miles further up the Similkameen river the following section was obtained of the measures by the Vermilion Forks Mining and Development Company, in bore hole No. 2:

Material.	Thickness.		Depth.	
	ft.	in.	ft.	in.
Clay	17	0		
Shale	18	0		
Sandstone	1	0		
Shale	36	0		
Sandstone	1	9		
Clay	2	9		
Carbonaceous shale	3	0	79	6
Coal	1	0		
Clay	7	4		
Coal	0	2		
Sandstone	27	11		
Shale	1	7		
Clay	12	6		
Shale	6	6		
Sandstone	17	7		
Shale	1	5		
Sandstone	11	7		
Carbonaceous shale	1	0	201	1
Coal	5	0		
Carbonaceous shale	3	6		
Shale	3	6	213	1
Coal	1	7		
Clay	2	11		
Shale and sandstone	23	1	240	9
Coal	3	0		
Sandstone and shale	16	0		
Coal	0	9		
Shale and sandstone	11	7	302	1

Aggregate of clean coal, 11 feet 6 inches.

The deepest hole bored in the whole coal basin was Blakemore's No. 2, which was sunk to a depth of 1,000 feet at a point on the Similkameen river, about two miles above Princeton. The following record shows the thickness and the depth at which each coal seam was cut. The only workable seam was struck at 676 feet. This was found to be ten feet seven inches thick, with a clay parting of six inches near the middle of it:—

Depth.	Thickness of coal seam.
At 95 feet	1 inch.
95 " 4 inches	1 "
395 " 8 "	2 inches.
404 " 0 "	2 "
427 " 2 "	8 "
475 " 6 "	6 "

Depth	Thickness of coal seam.
At 470 feet 0 inches	4 inches.
508 " 9 "	3 "
579 " 4 "	2 "
579 " 8 "	2 "
676 " 8 "	10 feet 7 inches.
694 " 6 "	1 inch.
699 " 3 "	1 foot 3 inches.
793 " 2 "	1 " 0 "

Total thickness of coal in 1,000 feet, fifteen feet.

Four miles up the Similkameen river a bore hole, sunk to a depth of 257 feet, only went through two feet five inches of coal; while a drill hol near the south end of the basin at Ashnola, which penetrated to a depth of 398 feet, gave no workable seams at all, and only a few bands of what has been called in the record "coaly shale."

A bore hole was also drilled near the western edge of the basin, where the sediments dip under the volcanics, and not far from where there is an outcrop of coal four feet thick. The depth of the hole is 863 feet, and in that distance seventeen seams of coal were cut through with an aggregate thickness of fifty and a half feet, of which the thickest seam was nine feet.

From a study of these records it would appear that most, though not all, of the workable seams are within 300 feet of the surface. It must be noted, however, that no prospecting by drilling has been done north of the Similkameen river.

The coal basin undoubtedly extends some distance north of the Similkameen river and beyond the limits of the sheet mapped, for outcrops of lignite and sandstone were found at the mouth of Summers creek. Two miles up this creek the sandstones are well exposed on the banks of the stream, and are here found to be overlaid by recent volcanic rocks. Farther north they appear to dip below the surface, but it is very likely that other areas of these coal measures may be discovered outcropping in places between here and Nicola lake.

Lignite outcrops in many places, both on the Similkameen and Tulameen rivers, also on Summers creek, Bromley creek and on Nine-mile creek. At the latter place a cut in the bank made by the stream discloses a bed fifteen feet in thickness of fairly clean lignite, with five very thin partings of clay, and all resting on white clay.

A selected sample from the big eighteen-foot seam at Princeton, worked by the Vermilion Forks Mining and Development Company, was sent to Mr. Hoffmann, of the Geological Survey Department. After analyzing it he found it to be a lignite, but one of the better class. Analysis by fast coking gave the following result:—

Hygroscopic water	16·17	per cent
Volatile combustible matter	37·58	"
Fixed carbon	41·67	"
Ash	4·58	"
	100·00	
Coke, per cent	46·25	

Character of coke, pulverulent; colour of ash, brownish yellow.

Last year Mr. Lawrence Lambe of this Department was able to correlate these lignite beds with the Coldwater group of Nicola lake, and similar beds on the Horsefly river. As a result of his investigations they have all been referred to Oligocene age, and are similar to the Amyzon beds of Colorado.

Though these beds are of the same age as the Coldwater group of the Nicola country, in which coal also occurs, there is a difference in the quality of the fuel contained in each. The Nicola coal is a true bituminous, whereas this is a lignite. The former, also, is considerably higher in fixed carbon and lower in water, while the fuel rate is 1·447, as against 1·108 of the Princeton coal.

Some of the beds of the Princeton coal basin are only in a primary stage of formation, and they still show the brown, woody fibre of the slightly altered vegetable remains. Much retinite also occurs in them. Some also have been completely destroyed by combustion, and it is to the combustion of an underlying bed of lignite that Dr. Dawson attributed the metamorphism and colour of the rocks at the Vermilion bluffs.

Post Oligocene.—The solid rocks of this age are all of volcanic origin. They have a very wide distribution and prove that this part of the country was the scene of tremendous volcanic activity during that period. Their area must have been considerably diminished during the glacial period, so that their present distribution cannot be taken as indicative of their original extent. Detached areas of these rocks, too small to be mapped, are often found capping the older rocks, and these must at one time have been continuous with the larger areas, but have been separated from them by erosion. An instance is on record where these volcanic rocks have acted as a shield to the underlying rocks, preventing the erosive action of glacial ice from removing the decomposed material of these underlying rocks, and only going so far as to remove the overlying volcanic sheet; so that now there is a much greater thickness of decomposed rock than is usually found in much glaciated regions, and a local condition has been produced which resembles the unglaciated regions of the Southern States.

These volcanics are the youngest rocks in the district, for they are seen on the Tulameen river and also on One-mile creek and Summers creek to rest directly on the rocks of the lignite series. On the Tulameen river the stream cuts through beds of clay, shale and sandstone overlaid by these volcanics for a distance of at least two and a half miles. The schists of the Roche river are overlaid by these volcanics to the north, east and west, and they also overlie the Copper Mountain series on the north and west. They consist of rhyolites and trachytes, andesites, basalt, tuffs and breccias. The surface lavas are often amygdaloidal, the vesicles being filled with chert, chalcedony or zeolites. Some agates and semi opal were found in the volcanic area east of the Coldwater river.

Some of these dikes cutting the Copper Mountain rock appear to be contemporaneous with these volcanic rocks, and in some way connected with them.

ORE DEPOSITS.

In the Roche River district the mineralized area is confined to a belt of soft talc, chloritic and hornblendic schists, lying about the junction of the Roche with the Pasayton river. The ore bodies are of two classes (1) small gold bearing fissure veins; (2) larger bedded veins, copper-bearing. The first are usually quartz veins from three inches to four feet in width, cutting across the strike of the schists, and dipping at angles from 60° to 90°. They carry, besides gold, bornite, tetrahedrite, chalcopyrite and pyrite. Sylvanite was also reported to occur, but an assay of a selected sample of one of the veins supposed to carry this mineral gave no trace of tellurium.

The second class contains larger ore bodies, lying parallel to the strike of the schists. These may be either quartz or mineralized bands in the schists. These carry some gold and the copper and iron sulphides, and the highest values are in copper.

Only two claims have been crown granted and surveyed, and the amount of development work done on all of them is not sufficient to prove the ore bodies, or test their permanence. The surveyed claims are the Pasayton and the Sailor Jack. On both these are small fissures. On the Pasayton is a fissure four inches wide from which samples were taken to test for tellurides, and on the Sailor Jack a fissure two feet wide cutting across a hornblende schist.

The greatest amount of work has been done on the Red Star and Anaconda claims. On these there is a belt of soft talc and chloritic schist about 400 feet wide, striking [illegible] and dipping vertically, and lying between mica schists. It appears to be traversed by a fault plane, along which bunches and lenses of white feldspar and quartz have been found, and which were first worked for their gold content. On development the vein ran into the talc schist, which proved to be highly mineralized with copper carbonates, melaconite and cuprite, and which was farther on replaced by bornite and chalcopyrite. Along with these were pyrite and arsenopyrite, siderite and some blende. A shaft has been sunk in the tunnel to a depth of sixty feet, but this had to be abandoned on account of the noxious gases. Some native copper occurs as sheets in little slips and fault planes in the schist.

Several other claims have been staked in this district, and though there are some indications of high grade ore occurring, the only work done on them has been just that which is sufficient to enable the owners to hold their claims.

Copper mountain was reported on by Mr. W. F. Robertson, the provincial mineralogist, in August 1901, and his report appears in the Annual Report of the Minister of Mines for British Columbia of that year. Since then development work has been extended farther to the eastward, but little more has been done in the neighbourhood of the river. In speaking of Copper Mountain camp and Copper Mountain ore bodies, it will be distinctly understood that Kennedy mountain will be included as well, for no distinction can be drawn between the two.

The camp includes about one hundred and thirty crown granted mineral claims, covering an area five miles long from east to west, and about four miles from north to south. Combination camp lies to the south of Copper mountain, but the ore bodies are much the same in character.

The country rock is a batholithic mass of igneous rock of very variable composition. It was found exceedingly difficult to classify it in the field on account of this variableness. From one part of the field to the other it appeared to range from an augite syenite to a gabbro, and as a mean between these two it was called in the Summary Report a diorite. On microscopic study, however, it was found to be a monzonite, very similar to the monzonite of the Rossland district. This has intruded into and almost entirely digested the older overlying sediments—limestones, argillites and quartzites—so that these only now appear as inclusions or remnants in the igneous rock. To the north and west it is overlaid by recent volcanic rocks. Along the southern and eastern border of the mineralized area the typical rock is best developed. Here, too, a gneissic structure is sometimes observed, or the dark minerals occur in segregated areas. To the north the rock becomes more feldspathic, and is cut by narrow veins of pink feldspar, quartz and magnetite.

Both the sediments and the igneous rock are intimately mixed with and cut by a multitude of later dikes of different ages, whose sequence cannot yet be perfectly worked out. These dikes have a general north and south trend and are quartz porphyry, rhyolite, granite porphyry, diabase and augite porphyrite, of which the first mentioned are apparently the most frequent. The whole series, except the later dikes, is traversed by a set of fracture and fault planes running in an almost east and west direction.

Two classes of ore bodies have been made out (1) those occurring at or near the contact of the sediments with an igneous rock, and (2) those occurring in the zones of fracture. Both are of a very indefinite character, without well defined boundaries. Examples of the first class are found at the southern end of Copper mountain, and on the west side of the Similkameen river. In this class ore is frequently found at the contact of the monzonite with a limestone, which may be very much altered. The ore here generally occurs as infiltrations in the small fracture planes with which the rock is traversed. The fissures cut both the igneous as well as the sedimentary rocks, and the metallic sulphides are found in both, but only in the neighbourhood of the contact. The fissures have been filled with secondary calcite, which acts as the gangue of the sulphides. Rhyolite and quartz porphyry dikes cut both kinds of rocks, and have apparently been injected after the fracturing and fissuring had ceased, for they are not themselves affected by any such dynamic action. The intruded rock alone has been fissured to allow of the flow of mineralized solutions. These later dikes are not in themselves mineralized, and do not appear to have had anything to do with the formation of the ore bodies. In the Jennie Silkman claim a highly mineralized diabase dike, which cuts an altered sedimentary rock along with a quartz porphyry, seems to be responsible for the formation of the ore. The minerals occurring in this class are chalcopyrite, pyrite, pyrrhotite, bornite and calcite, with a little magnetite. Bornite is confined to the southern portion of the camp. The Sunset, Helen H. Gardner, Jennie Silkman and Copper Farm claims are examples of this class.

The second class of ore bodies occurs in the centre of Copper mountain and eastward across Wolf creek. In this case the ore occupies a zone of fracturing, which strikes about north 75° east. It often happens that the country rock has been brecciated and the fragments cemented together by calcite, or it is traversed by a network of small calcite veins with a north 75° east trend. These fissures are most abundant about the middle of the camp, and die out to the north and south. They sometimes attain a width of two feet, but are more often only an inch or two. They cut all the rocks except some of the later dikes. These dikes strike at right angles to the course of the fissures, cutting off the ore bodies, and they do not seem to have been affected by any strains or stresses, except those which are consequent on the cooling of the igneous body. Pyrite, chalcopyrite, mispickel and magnetite occur in the calcite veins. Magnetite sometimes replaces the calcite altogether in the veins, and forms the gangue for the other minerals. In the northern part of the district the little fissures are filled with feldspar, quartz or magnetite to the entire exclusion of calcite. The Triangle Fraction, Red Eagle, Ada B., Frisco, Annie L. and other claims running east and west across the middle of the camp are examples of this class

Besides being concentrated in the zones of fracture the copper and iron sulphides appear often to be original constituents of the monzonite, for they appear as idiomorphic crystals, disseminated through it without any connexion with each other, and until a great deal more developmen [illegible] is done on the claims it will be difficult to give a correct [illegible] of the formation of the ore bodies. At present not many [illegible] have been explored to a depth lower than the limit of surface oxidation. Some deep drilling had been done on the Princess May and other claims during 1905, but the results have never been made known.

It will be noted that one of the features of these ore deposits is the association of the oxides of iron with the sulphides, magnetite occurring with pyrite and chalcopyrite, a feature which has been considered by the best authorities to be characteristic of contact deposits, and particularly the contact of limestone or a calcareous rock with an igneous one. Though it is not always possible on Copper mountain to discover an igneous rock and limestone contact, wherever this association of oxides and sulphides occurs, it must not always be inferred that there never was one there. Many small areas of limestone and argillite have been found as inclusions in the monzonite, a fact which goes to prove that before the intrusion of the monzonite the country rock of Copper mountain was a sedimentary one composed of these rocks, and that the monzonite had eaten into and assimilated all but the remnants that now exist. It is probable, however, that the molten magma never actually reached the surface, but cooled at depth under great pressure into a rock of granitic texture while the sediments still overlay it. Extensive erosion may have followed, going so far as to remove almost entirely the overlying sediments, and bringing to the surface the intrusive granular monzonite and its once deep-seated contacts with the sediments; or even going beyond this so that the sediments were removed entirely and the monzonite exposed, but still showing the effect of contact metamorphism. It would be premature at the present stage of development of the camp to say how much of the mineralization is attributable to the effects of contact metamorphism, but it appears altogether likely that the first class of ore bodies mentioned may be referred to this cause, while possibly there may have been a later fracturing and fissuring with mineralization to account for the second class.

Owing to the nature of the occurrence of the ore on Copper mountain it is a difficult matter to make estimates of the average values that the rock would give on assay. The ore bodies have no definite boundaries, in fact the whole mountain is more or less mineralized with concentration taken place along certain lines, and what is classed as ore to-day may be too low a grade to give a profit tomorrow, depending altogether on the price of copper and the cost of mining. The boundaries then will be merely commercial ones. Mr. W. F. Robertson made assays of samples from many of the different claims in 1901, and the results he obtained were from one and a half to three per cent in copper of average samples, with selected samples going up to eight per cent. Most of them carried a small amount in gold. It will be seen by this that these ore bodies are very low grade, but this is compensated for by their great size and the ease with which they can be worked.

In the country lying between One-mile and Five-mile creeks, and on the slope of Five-mile creek, several claims have been located, but only the western portion of this area came within the district examined. The United Empire group, consisting of nine claims, is on Allison mountain, and occurs in the same series of metamorphosed sediments as occupies Kennedy mountain. The whole hill is heavily covered with wash, and the rock, wherever exposed, is decomposed to a much greater extent than in any other part of the country, due perhaps to a covering of volcanic flows during the glacial period, which prevented this decomposed rock from being removed by the scouring action of the glacier. At the base of the hill is a thick deposit of clay and detritus washed down from the hill, and heavily charged with copper carbonate. This has probably been derived from the leaching out of a copper-bearing quartz vein higher up the hill carrying the sulphides of copper. Evidence in support of this is drawn from a shaft forty feet deep sunk about half way up the hill, at the bottom of which blocks of quartz, carrying chalcopyrite, occur in the decomposed rock. It is probable that there is a vein of quartz carrying copper at this place, but not enough work has been done to demonstrate the size of the vein or its strike. Surface indications, however, point to its having an east and west strike across the strike of the country rock, and in conformity with the strike of the fracture planes on Copper mountain.

BEAR CREEK.

At the end of the season a hurried reconnaissance was made of a mineralized belt of rocks running from the Tulameen river, at Champion creek, northward past the head of Bear creek, to the Coldwater river. Some very promising mining properties are being exploited in this region, and this belt of rocks well warrants a more extended geological study.

Briefly stated the geological conditions are as follows:—Stretching across in a northerly direction from the mouth of Champion creek to the head of Coldwater river is a belt of light-coloured granite. In contact with this on the east side is a series of metamorphosed sediments—limestones, quartzite and schists—extending from the Coldwater river to the Fish lakes. From the Fish lakes to the forks of Eagle creek the granite is in contact with a dike-like mass of peridotite a mile or two wide, which then strikes easterly at a sharp angle with the strike of the granite. In this angle, between the granite and the peridotite, is another small area of quartzite, limestone and mica schists, which extends south to the Tulameen river and terminates at Champion creek. Bordering the peridotite and schists on the east is a large body of pyroxenite, which extends from the falls on Bear creek, where the wagon road crosses it, southward across the Tulameen river, where it comes in contact with the granite. The pyroxenite is succeeded on the east by enormous masses of volcanic rocks, which have undergone considerable metamorphism, and are earlier in age than those volcanic rocks previously referred to in this report as occurring on the southern portion of the Similkameen river. Dikes of diabase, quartz-porphyry and granite-porphyry cut all the other rocks and are consequently later in origin.

Contacts between the granite and schists, between the granite and peridotite, and between the schists and peridotite and pyroxenite, were discovered and studied in the field, and from these the geological relations were worked out. The schists, which are probably metamorphosed sediments, with the limestones and quartzites, are the oldest rocks in the district, for they are cut by all the others and are found as inclusions in the granite and in the peridotite. Next in age comes the peridotite, and with this must be included the pyroxenite, though the latter is slightly the younger, for on Eagle creek dikes of pyroxenite were found cutting the peridotite. Prof. J. F. Kemp, who examined the district in 1900, reports the same conditions on the south side of the Tulameen river. The next rock in the sequence is the large batholithic mass of granite lying to the west. Contacts between this and the older rocks are well shown on the Tulameen river and on Eagle creek. Following the granite intrusions are the sheared and metamorphosed volcanic rocks, and later again are the dikes which have penetrated all the preceding rocks.

Mineral claims have been located all along this granite contact from Champion creek across to the Coldwater river, and for many years the placers of the Tulameen river and its tributaries below Champion creek have been profitably worked for gold and platinum. These placers are being gradually exhausted, and the Tulameen river, from being the principal producer of platinum on the North American continent, has dwindled down to an annual output of thirty or forty ounces of that metal. Mining activity, however, is now being revived, and the production from lode mining will probably soon be far greater than it ever was in the best days of the placer miner.

Most of the mineral claims have been located in the area of schists, limestones and quartzites, and some in the peridotite and pyroxenite belt. The metals for which they have been staked are gold, silver and copper; and the minerals occurring are pyrrhotite, pyrite, galena, chalcopyrite and calcite, with some zinc blende and molybdenite.

Molybdenite is found in several places along the granite contact. At Independent camp, at the head of the Coldwater river, it occurs in fine scales in the granite porphyry, and at Champion creek it is found in little quartz stringers cutting the schists at and near the contact with the granite.

Among the most promising claims in the whole district are the St. Lawrence group, owned by the Similkameen Mining and Smelting Company of Vancouver. These were first located in the fall of 1900 by a party of Swedes, and are situated on the western side of Bear creek, and on the contact of the granite with the schists and limestones. The schists are mica schists, and they are interbedded with narrow bands of crystalline limestone. They dip at about 65° towards the granite, and are cut by some large and highly mineralized dikes of granite-porphyry, which have a north and south trend approximately parallel to the trend of the granite. The ore is always found associated with the limestone, and frequently replaces the lime bands entirely. The granite porphyry dikes appear to be the source of the ore. The limestone being the most soluble rocks have acted as channels for mineralized solutions from the dikes, and they have at times become entirely replaced by sulphides. These solutions ascending from below and following the lime bands have deposited their sulphides against the mica schist, which always acts as a hanging wall to the vein. Two veins have been opened up on this group, each of them from seven to eight feet wide, and the ore in them appears to be almost pure pyrrhotite. The values are high in copper, gold and silver, and altogether the property has the ear marks of a permanent producing mine.

Another important group of claims is the Independent group, owned by Messrs. Johnson, Holmes & Henning, and situated on the summit of the divide between Bear creek and the Coldwater river. This group is also on the contact of the granite body with mica schists. Here the ore body is a highly mineralized zone of rock extending from the edge of the schists about 1,000 feet westward into the granite. Two thousand feet away from the schists the granite becomes gneissic though still holding inclusions of the mica schists. No sharp line of contact could be discovered between the ore body and the unaltered granite, only that the mineralization by sulphides appears to gradually decrease until at 1,200 feet away from the schist it disappears. The ore body is highly altered and kaolinized, where mineralization is greatest, and it appears to be of the nature of a dike of granite-porphyry intruded between the schists and the granite, though it is possible it may only be a mineralization and alteration of the same granite at and near the contact with the schists. Inclusions of mica schists occur in the unaltered granite, as well as in the ore body. The greatest alteration is about the centre of the mineralized zone, where a small vein of pure iron and copper sulphides cuts the porphyry at an angle of 45 degrees. The feldspar here is kaolinized, though the quartz is unaltered, and some secondary calcite has been developed. Mineralization throughout the body of the porphyry is usually by individual crystals of iron and copper pyrites, more rarely by veins and bunches of these minerals. Only in the highly altered zone does oxidation extend to a depth of twenty feet from the surface. Some molybdenite occurs in thin seams and flakes near the contact with the mica schist. The values are entirely in copper, and are low, but the ore body is an enormous one. The group consists of ten claims, which have all been staked on the same contact, running down into the Coldwater river.

Numerous other claims were visited in this section of country, among them being the Keruna group on Bear creek, and the Boulder Creek camp, east of Bear creek. The former lies in the same series of altered sedimentary rocks as were described on the St. Lawrence group. These are cut by dikes of a porphyritic character, which strike about 330°. The ore occurs as little veins and bunches in the sediments at and near the contact of the dikes. The minerals found are pyrite, chalcopyrite and pyrrhotite, and the values are in gold and silver.

At Boulder creek the claims are located in a soft, green serpentine, which often has a schistose structure developed in it, and which appears to be an altered volcanic rock. These ore bodies are in blanket veins, interbedded with the country rock, and the minerals occurring are pyrite, chalcopyrite and some galena. The values are in gold or copper, or both, the one increasing as the other decreases.

Owing to the enormous rise in the price of platinum in the last year, and to the fact that the basin of the Tulameen river once produced a larger amount of platinum than any other part of North America, it is altogether probable that attempts will again be made by interested parties in the near future to locate the source of the metal in this district, or to work some of the higher bench deposits of gravel which are known to carry platinum, but which necessitated too large an outlay of capital to have been worked before. Prof. J. F. Kemp spent about three months in the summer of 1900 in investigating the geology of the platinum, and though he was not successful to the extent of finding any large bodies of rock which could be profitably mined, he was able to throw a great deal of light on the origin and occurrence of the metal. His results are embodied in bulletin 193, of the United States Geological Survey.

The Tulameen section of the country presents a great many more difficulties to the prospector than the Similkameen country.

The former is very heavily timbered and trails are few and rough. Rock exposures, however, are most common, except where the country is underlaid by the schists and limestones, as in the upper parts of Bear creek. Here the growth of the timber is heavier than usual, and the country is so covered with drift that rock exposures very rarely occur, and it has only been by much labour that ore bodies have been located. It is here, though, that conditions for the formation of ore bodies are so favourable that other important discoveries are to be looked for in the future.

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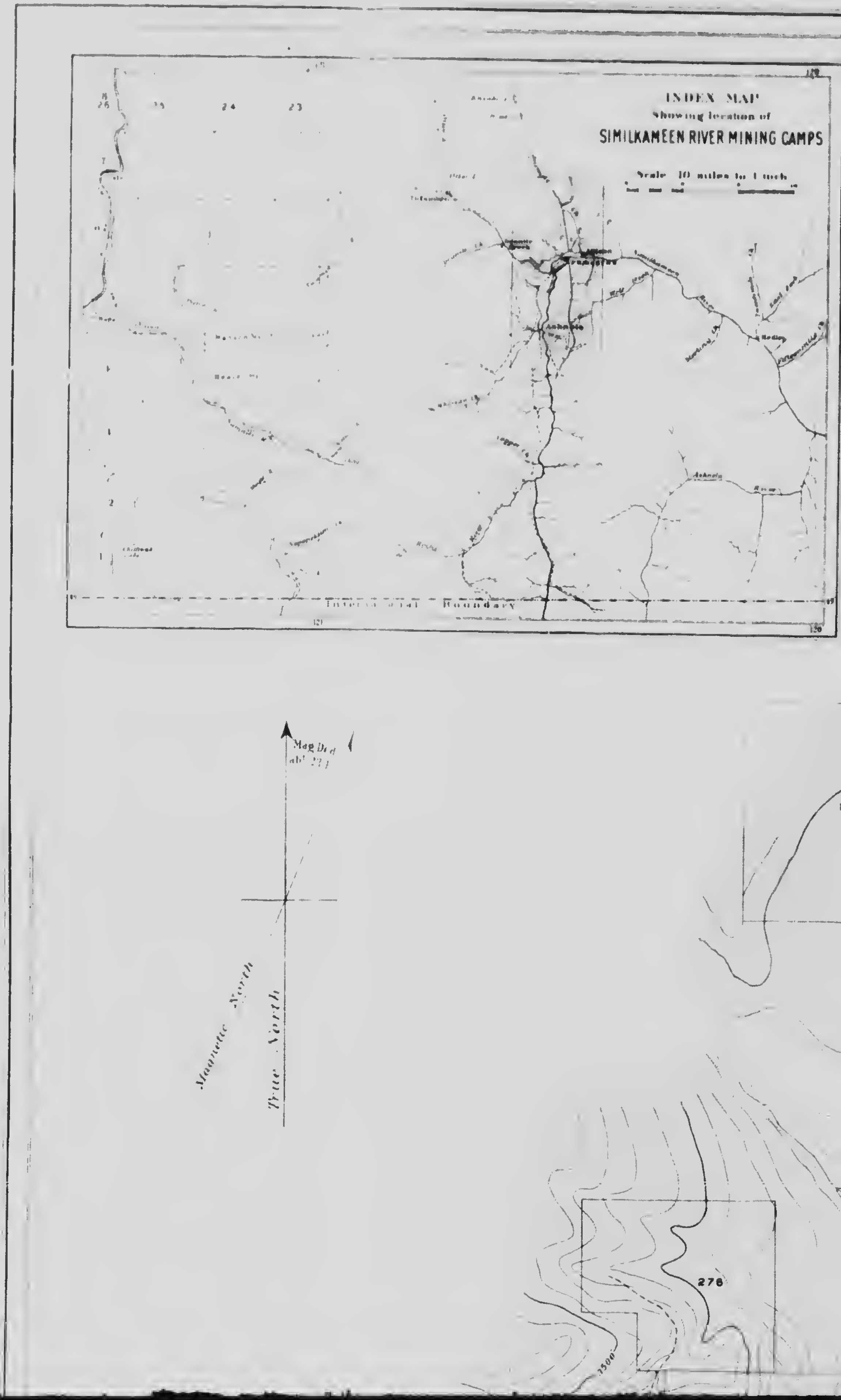
INDEX MAP
Showing location of
SIMILKAMEEN RIVER MINING CAMPS
Boundary
Magnetic North
True North
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DEPARTMENT OF MINES

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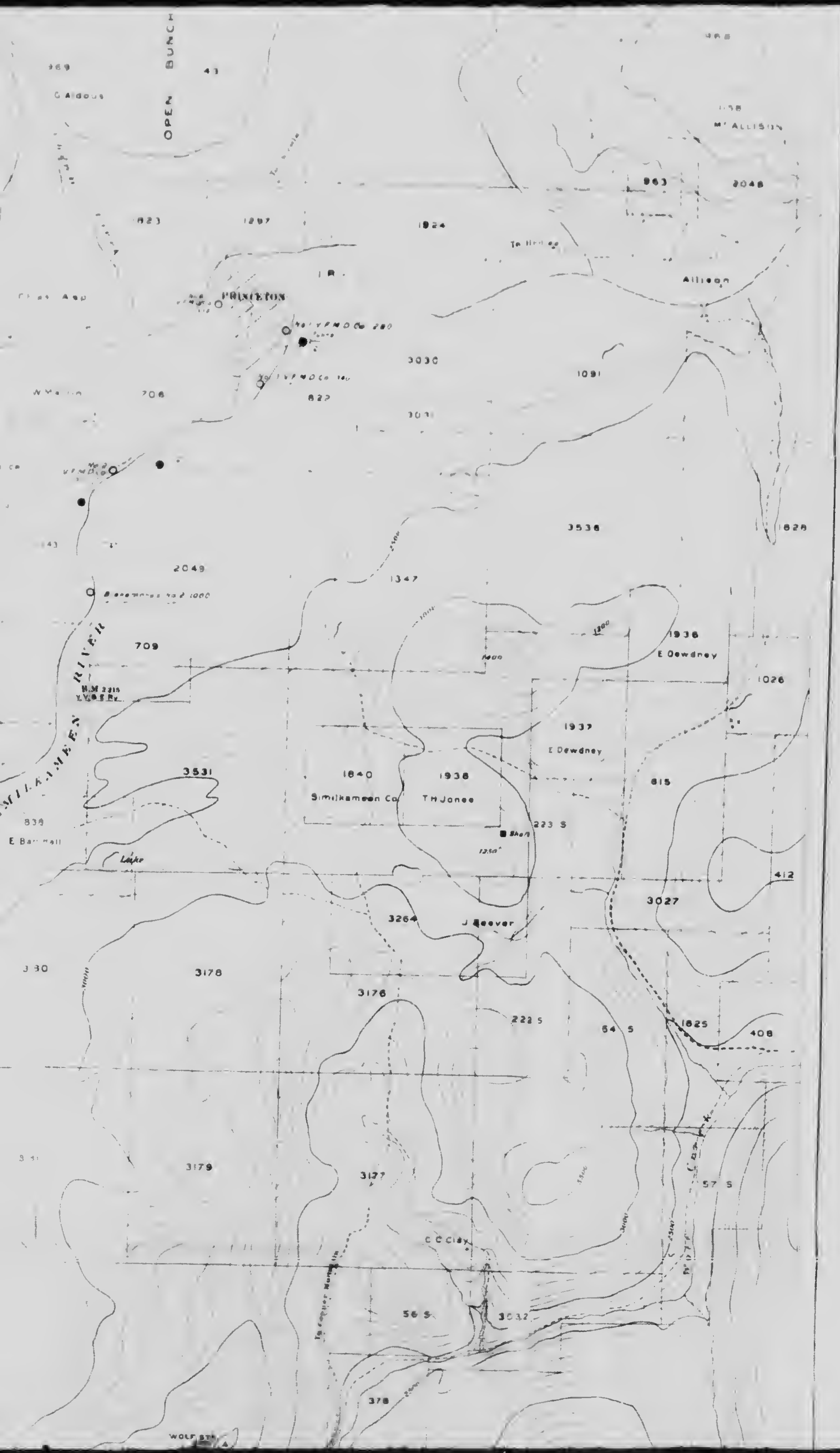

OPEN BUNCH
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C C Clay
56 S
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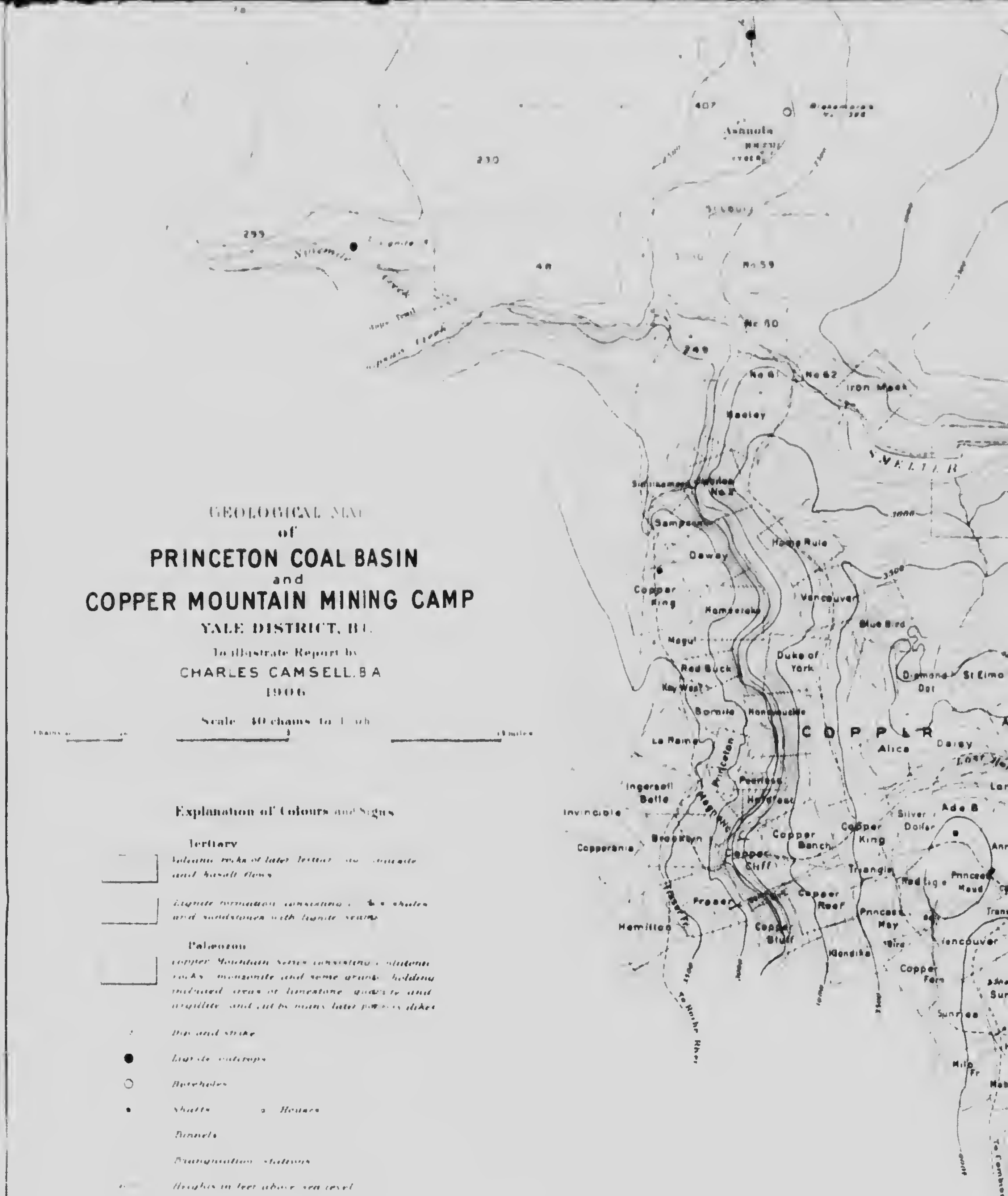
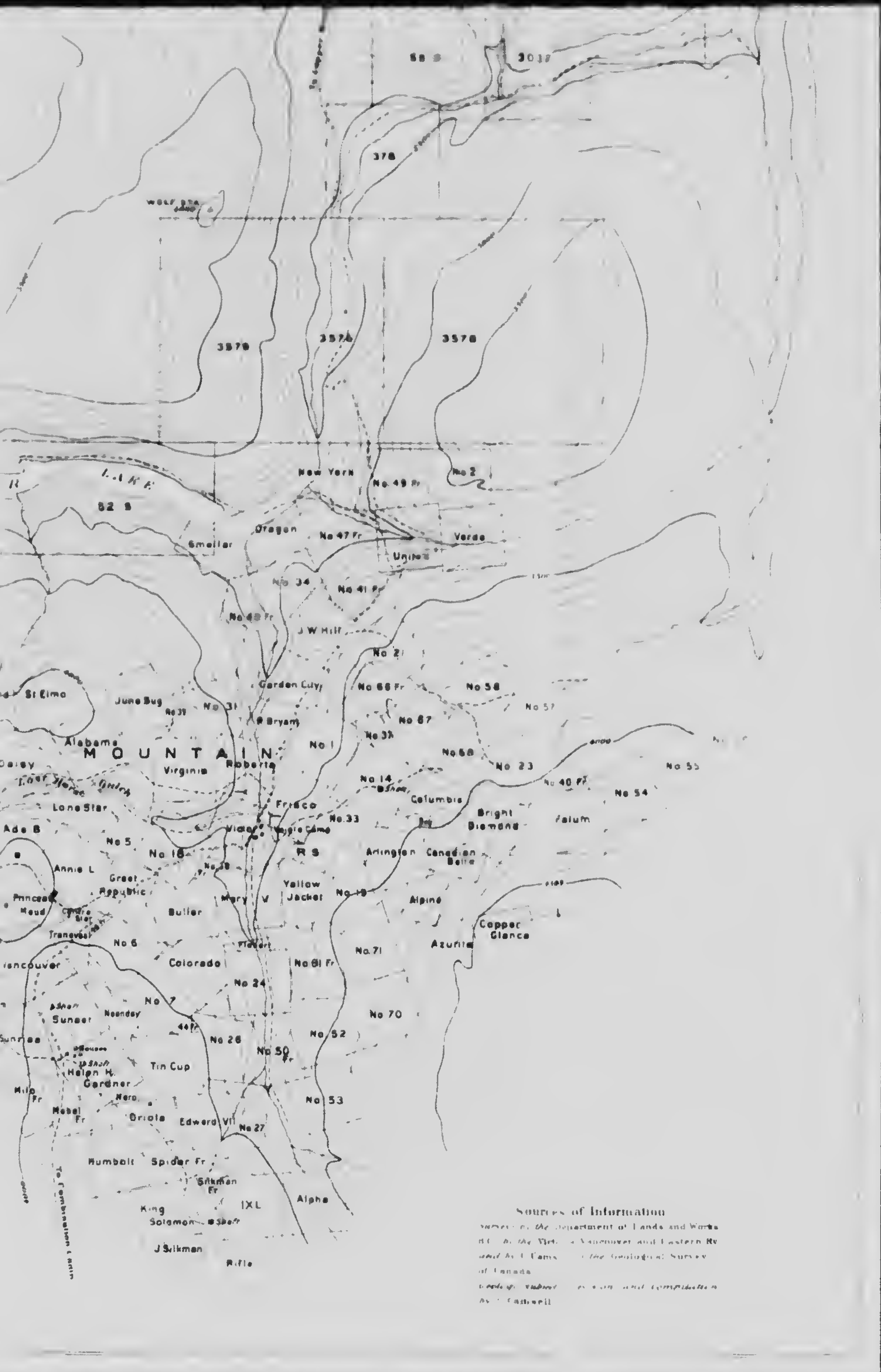

GEOLOGICAL MAP
of
PRINCETON COAL BASIN
and
COPPER MOUNTAIN MINING CAMP
YALE DISTRICT, B.C.
To illustrate Report by
CHARLES CAMSELL, B.A.
1906
Explanation of Colours and Signs
Tertiary
Paleozoic
Annola
St Louis
No 59
No 60
No 61
No 62
Iron Mask
Sampson
Dewey
Home Rule
Copper King
Vancouver
Blue Bird
Red Buck
Key West
Duke of York
Bornite
La Reine
St Elmo
COPPER
Alice
Ingersoll Belle
Invincible
Peerless
Copperania
Brooklyn
Copper Bench
Copper King
Copper Cliff
Fraser
Copper Reef
Hamilton
Copper Bluff
Princess May
Klondike
Copper Fern
Sunrise
Silver Dollar
Ada B
Vancouver
Princeton



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